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STEEL CONSUMPTION IN AXIS EUROPE IN 1943

Steel consumption in Axis Europe in 1943 is estimated to be 35,250,000 ingot metric tons. This figure is about 5 million tons below the NEW and OSS estimates for 1942. The disparity does not represent so much a decline in requirements as an apparent overstatement in the NEW study (September 1942) which was used as the basis for the previous OSS estimate. If the NEW figure is adjusted, Axis steel requirements in 1943 are about 1,050,000 tons below 1942. Details of these estimates are discussed in the attached tables and notes to this study.

The principal significance of the 1943 steel consumption figure lies in its emphasis on the safe margin between steel capacity and requirements within which Axis Europe is operating. According to present estimates, steel producing capacity exceeds the above consumption requirements by almost 20 million tons. This means that nearly 40% of Axis steel capacity could be lost without seriously interfering with current needs. This margin is sufficient to overcome major damage to steel plants in the Ruhr. Even the problem of quality steel production should be soluble under these conditions. It should be emphasized, however, that French and Belgian steel

capacity becomes increasingly important as activity in the Ruhr is frustrated, so long as the Axis desires to maintain its present level of output. 1/

When related to Germany's defensive capabilities, it is even more apparent that steel is not a limiting factor. On the basis of wholly defensive needs, steel requirements could be set several million tons lower. This could be accomplished by restrictions in naval and merchant shipping, in the railroad program, and in parts of the industrial program. At this lower level of consumption, present capacity would provide an excess ammounting to perhaps 100% of basic defense needs.

The consumption pattern is also significant in comparison with United Nations' requirements. Axis Europe's 1943 requirement is about 40% of the United States's, about 170% of the United Kingdom's, and 25% of the combined requirement, as shown in the following condensed table:

1/ The steel requirement estimated in this paper is 6-7 million ingot tons below current estimates of Axis steel production. The latter estimates may be rather high and are to be further investigated in the future. On the other hand, the margin of error in the estimation of requirements is believed to be considerably larger than in the case of supply. Nevertheless, the conclusions of this paper would not be vitiated by a margin of error of 20-25% in the requirements estimate.

(000's of ingot metric tons)

Military	Axis Europe	U.S. 1/	U.K. 1/
Ammunition	7,000	11,703	3,380
Field Equipment	3,000	4,400	1,484
Armored fighting vehicles	1,250	8,330	977
Motor vehicles	790	3,652	802
Artillery and small arms	850	2,164	974
Direct military construction	2,600	6,608	1,018
Aircraft	690	4,315	1,302
Naval construction	870	7,688	1,692
TOTAL MILITARY	17,050	48,770	11,629
Industrial & Civilian			
Railroads	7,800	7,790	1,617
Construction	810	4,941	884
Merchant Shipping	790	8,526	1,883
Industrial and Agricultural equipment	7,650	14,280	4,410
Miscellaneous	1,150	---	---
TOTAL INDUSTRIAL & CIVILIAN	18,200	34,537	8,794
GRAND TOTAL	35,250	84,307	20,423

This table also indicates important divergencies within the patterns. The Axis railroad program, for example, is as large as ours, and it accounts for almost 20% of the total compared to less than 10% in this country. The enormous preponderance of the Allies in tanks, motor vehicles, aircraft, and shipping is also illustrated by

1/ Excluding exports and lend-lease.

this table. The combined US-UK military program is, in fact, almost four times that of Axis Europe.

A tabulation of this type, showing a broad comparison of the military strength of opposing Powers in terms of steel, might well be expanded to include the requirements of the USSR and Japan, in order to facilitate both an analysis of fighting strenght and of the strategic significance of the various steel indices.

NOTE

Ingot = Gross = Weight of steel as poured from furnace.

Rough stock = Intermediate = Weight of steel as delivered to consumer.

Finished = Net = Weight of steel in finished product.

AMMUNITION

The ingot steel requirement for 1943 is estimated at 7 million tons. This is based on 1942's estimated expenditure of steel in projectiles and cases for gun and artillery ammunition and on estimated production of torpedoes and bombs. This estimate for 1942, explained in the following tables and text, totals 6,420,000 ingot tons of steel.

A figure of 7 million tons for 1943 seems reasonable. Increased United Nations activity in Western Europe in 1943 will probably roughly counter-balance decreased expenditure on the Russian front from February to July 1943 and the late starting date of the Axis offensive. A lower level of R.A.F. bombing activity may mean smaller bomb production (but perhaps heavier bombs), while a widening substitution of steel for brass cases will raise the requirement for that item. As far as possible, however, the Axis will probably try to expand production against the eventuality of heavier fighting as the war in Europe approaches a climax.

The intermediate figure is 4.9 million tons.

AXIS AMMUNITION EXPENDITURE AND PRODUCTION IN 1942

000's of ingot metric tons

I. Expenditure on Russian Front 1/		
German Army	3,846	
Axis Satellite	50	
TOTAL		3,896
II. Expenditure on North African Front 1/		80
III. Total Small Arms Ammunition 2/		994
IV. Steel Cartridge Cases		1,020
V. Torpedoes		60
VI. Bombs		370
GRAND TOTAL		6,420

1/ Small arms and cartridge cases excluded.
2/ Cartridge cases excluded.

ESTIMATE OF AXIS AMMUNITION EXPENDITURE
IN 1942

I. Russian Front

1. Weights of projectiles of German ammunition of various calibres were determined from reports on captured enemy materiel. The weight of American projectiles for similar calibres was determined from the Complete Round Charts. Where calibres were not exactly the same (e.g., 90 mm U.S. and 88 mm German), the U.S. weight was adjusted on the basis of a curve of weight: calibre. Where German weights were not available, they were estimated on the basis of available comparisons.

The adjusted U.S. calibres were then tabulated in rough stock form from U.S. Bills of Materials. Steel cartridge cases were not included, and when separate data were not given for projectile and case, a deduction was made on the basis of weights where separate data were available. The rough stock figures were converted to ingot weight on a ratio of .72 for carbon and .65 for alloy. The then determinable ratio of U.S. ingot: U.S. finished weight was applied to the finished weights of German projectiles to obtain the ingot weight of each German projectile. It was assumed that ammunition of other Axis countries had similar weights.

2. The weight of ammunition expended per day per division in pounds of ingot steel was then calculated. The number of guns of infantry, GHQ, Panzer, and Motorized

thirds of the German.

II. North African Front.

The German and Italian divisions (taken at 2/3 the fire power of the Germans) were assumed to be engaged in quiet activity from January to May and during July-August. Expenditure was on an intense level during the German advance to El Alamein in May and the British advance in November-December. A normal rate of activity was assumed for September-October, when the front was less quiet than in preceding months.

III. Total Small Arms Ammunitions.

Adequate comparable data on individual items of SAA are lacking; therefore the U.S. ratio of SAA = 25% of large calibre was used. Insofar as the Germans are employing tungsten carbide cores in their SAA-AP projectiles, this may be an overstatement.

IV. Steel Cartridge Cases.

In general, steel cartridge cases are equal to about 25% of the weight of the projectile, although this figure may be higher for smaller calibres. On this basis, the requirement would be 1,242,000 tons. However, it has been estimated that about 225,000 tons of bars are consumed in cartridge cases. As equal volumes of brass and steel weigh about the same amount, the requirement for steel is about 1,020,000 tons. The broader use of steel suggested by some reports may indicate that this is an understatement.

Divisions was multiplied by the FFC rates of rounds per gun per day. The resulting product was multiplied by the ingot weight of each shell, yielding the ingot weight of ammunition expended per day per division under conditions of intense, normal, and quiet fighting.

3. These figures were then combined with a schedule of division days of fighting under intense, normal, and quiet conditions on the five major sectors of the Russian front, month by month, from June to December 1942. The activity schedule was worked up by the USSR Division and the order of battle by the Labor Supply Section. The resulting monthly changes were correlated sufficiently closely with the Labor Supply Section's casualty index to calculate ammunition expenditure for the first five months of the year (the activity schedule does not include these months). This procedure yielded a total of 4,808,000 ingot tons. However, it has been found that, on the basis of British fighting in North Africa, FFC rates are about 20% higher than actual wastage rates, on the average. Accordingly, this total was adjusted downward by 20%.

4. For Axis Satellite divisions a similar procedure was followed, with two exceptions. First, as very few of the Satellite divisions were active, particularly in the first part of the year, only active divisions were considered (in the German case, all divisions were considered). Second, all Satellite divisions were assumed to be infantry divisions, with fire power equal to two-

V and VI. Torpedoes and Bombs.

Based on Axis 1942 production and U.S. 1943 production.

MISCELLANEOUS FIELD EQUIPMENT

U. S. 1943 consumption of steel for this item is estimated at something more than 4 million ingot tons. Although the Axis armies are probably as great in size as the U.S. army, the Axis figure is most likely lower for three reasons:

1. The Axis has had a longer period to build up a stock of such equipment.

2. The U.S. has to supply other United Nations.

3. The United Nations are planning large-scale offensive actions.

This item is therefore estimated at 2,100,000 tons intermediate and 3,000,000 tons ingot.

ARMORED FIGHTING VEHICLES

Metric tons

	Finished	Intermediate	Gross
Tanks	354,000	490,000	900,000
Other AFV's	135,000	195,000	350,000
TOTAL	489,000	685,000	1,250,000

Tanks

OSS estimates 1943 Axis tank production at 10,000 1/ tanks, averaging 28 metric tons in weight. Deductions must be made from this total as follows:

1/ There is reason to believe that this estimate may be too high.

Stowage @ 800 lbs. per crew member	1800 lbs.
Rubber @ 30 lbs./tons	840
Other metals (2% of total)	1230
	4000 lbs.

Thus the finished weight of steel in 10,000 tanks is 10,000 x 26.2 tons, or 262,000 tons. If spare are added at 35%, this total becomes 354,000 tons.

Conversion to intermediate and gross weight was carried out on the basis of American and British practice as follows:

	Finished	Intermediate	Gross
Castings (30% of total)	106,000	110,000	200,000
Rolled products (70% of total)	248,000	380,000	700,000
TOTAL	354,000	490,000	900,000

Other AFV's

This figure includes armored cars, half-tracks, self-propelled artillery, etc. Output in 1943 is estimated at 10,000 units, averaging ten tons in finished form (not counting spares). Computed in a manner similar to that used for tanks.

ARTILLERY AND SMALL ARMS

Estimates of artillery are highly unsatisfactory. In the absence of better information, the MEW figures have been accepted.

Intermediate	425,000
Gross	850,000

DIRECT MILITARY CONSTRUCTION

	000's metric tons	
	Intermediate	Gross
Direct Military	1625	2600

Direct Military

Based on U.S. figure. U.S. consumption of steel (intermediate) in 1943 for direct military construction estimated at something over 4 million tons, but the annual rate in the last quarter will be about 3 million tons. Even considering the construction of defenses for the "Fortress of Europe", the Axis would hardly consume much more than half this amount. The fact that the Axis military program is longer-lived than ours also indicates that their outlay for military construction should be well below ours.

Conversion rate of 2 intermediate: gross = 62.5% based on MEW steel study.

NAVAL CONSTRUCTION

See notes to Merchant Shipping

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RAILROADS (000's metric tons)

	N.Z.A. Estimate 1942		OSS Estimate 1943	
	Rough Stock	Ingot	Rough Stock	Ingot
A. Track and structure				
1. Maintenance and renewal -- Altreich	400	1,300	600	1,300
2. Maintenance and renewal -- incorporated territories and Protectorate	250			
3. Maintenance and renewal -- rest of Axis Europe			150	
4. Doubling and new construction (Axis Europe, excluding Eastern Front)	250		150	
5. Repair of war damage to permanent way and new construction on Eastern Front	750	1,050	300	450
6. Repair of damage to bridges, stations, workshops, etc.	600	850	400	550
TOTAL	2,250	3,200	1,600	2,300

RAILROADS (Con't.)

	M.E.W. Estimate 1942		OSS Estimate 1943	
	Rough Stock	Ingot	Rough Stock	Ingot
B. Equipment				
1. Mainline locomotive construction	350	600	700	1,050
2. Main line freight car construction	2,900	4,400	2,250	3,450
3. Maintenance and repair of main line locomotive cars	300	400	400	500
4. Construction and maintenance of equipment for narrow guage railroads	300	500	300	500
TOTAL	3,850	5,900 1/	3,650	5,500
GRAND TOTAL	6,100	9,100	5,250	7,800

1/ Given as 5,500 in MEW report, apparently due to error in addition.

General

Co-efficient for the conversion of net steel content to rough stock weight, and of rough stock to ingot weight, have been taken from MEW report.

Notes on estimates

A.1.)
A.2.)
A.3.) These estimates assume:

1. That the Germans must expend steel on the maintenance of their own permanent way (including that in incorporated territory and the Protectorate) at approximately the level of the immediate pre-war years (1934-38); and

2. That a substantially lower expenditure per mile of line is feasible in the rest of Europe by neglecting lines which are not of prime military importance.

It should be noted that the estimate for Germany involves the replacement of only about 2% of track per annum, as compared with the "theoretical" requirement of 5%. A larger allocation for maintenance will ultimately be necessary, but probably not in 1943.

A.4. The estimate is reduced from 1942 because ground intelligence reports indicate that construction activity in Poland and Norway has declined.

A.5. It is assumed that requirements on the Eastern Front are much reduced, partly because the most urgent construction should have been completed by the end of 1942, and partly because the German army is no longer advancing. Ground intelligence reports indicate that a substantial proportion of the rails required on the Eastern Front have been taken from unessential lines in France and Belgium.

A.6. Repairs to bridges in the West and the Balkans should have been largely completed by the end of 1942, and repair to bridges in the East should be a smaller item because the German Army is no longer advancing. Necessary repairs to stations and workshops have been increased by the heavier air attacks in the West, but they do not represent a large tonnage of new steel requirements.

B.1. This estimate is based on the assumptions:

1. that the Germans will be able to build 4500 locomotives in 1943; and

2. that the average locomotive will weigh 100 tons [the weight of the new model 62 on which production is being concentrated]. This is almost twice the output assumed by the MEW in 1942, but considerably less than the German program which calls for production at the rate of 7500 per annum by the end of 1943.

B.2. This estimate is based on the following assumptions:

1. that the Germans will be able to build 150,000 freight and tanks cars in 1943;

2. that the bulk of production consists of 20 ton cars; and

3. that 20% of the total consists of tank cars. The MEW estimate for 1942 is based on an output of 200,000 cars, which is certainly much too high. It is now known that the German program calls for production at the rate of 200,000 per annum by the end of 1943.

B-3. Requirements should be higher than in 1942 because damage from air attack has increased and because more average locomotives and cars are in service. On the other hand, some important workshop facilities have been severely damaged by air attack, and it is not certain that those remaining have the capacity to complete all desirable repairs.

B-4. In the absence of additional information the MEW estimate for 1942 has been accepted for 1943.

NONMILITARY CONSTRUCTION

	000's metric tons	
	Intermediate	Gross
Plants	400	640
Other	100	160
TOTAL	500	810

MERCHANT AND NAVAL SHIP CONSTRUCTION, AXIS EUROPE, 1943.

(metric tons)

MEW Estimate of GRT		Tonnage GRT	Hull		Main propelling machinery and boilers			Auxiliary machinery and Equipment			Total Steel Final Weight
			% of Column 2	Weight	% of Column 2	Weight	less 50% Iron	% of Column 2	Weight	less 40% Iron	
773,000	Merchant ships	600,000	45.0	270,000	20.0	120,000	60,000	5.0	30,000	18,000	318,000
80,000	Cruisers and Destroyers	40,000	60.0	24,000	20.0	8,000	4,000	7.0	2,800	1,680	
15,000	Escort vessels	15,000	62.5	9,375	12.1	1,815	908	15.0	2,250	1,350	
8,250	Minesweepers	20,000	62.5	12,500	12.1	2,420	1,210	15.0	3,000	1,800	
	Submarines	200,000	63.0	126,000	24.5	49,000	24,500	1.8	3,600	2,160	405,661
11,200	E/R boats	11,000	42.0	4,620	17.0	1,870	935	4.0	440	264	
160,000	Tank landing craft	80,000	50.0	40,000	11.25	9,000	4,500	2.0	1,600	960	
130,000	Steel ferries	100,000	50.0	50,000	9.2	9,200	4,600	2.0	2,000	1,200	
30,000	Barges	20,000	40.0	8,000	2.5	500	250	--	-----	-----	
5,000	Pontoons and small craft	5,000	42.0	2,100	---	-----	-----	---	-----	-----	
150,000	Floating docks, etc.	125,000	60.0	75,000	---	-----	-----	5.0	6,250	3,750	
1,516,450	TOTAL	1,216,000		621,595		201,805	100,902		51,940	31,164	753,661

NOTE: Conversions based on MEW steel study. For explanation, see attached note.

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STEEL CONSUMPTION IN AIRCRAFT, 1943

(short tons)

Nearest U.S.Type	Axis Type of Aircraft	Annual Production (units)	Unit weight of steel (Rough stock) Alloy	Carbon	Total	Unit weight of steel (Ingot) Alloy (1.83)	Carbon (1.43)	Total	Total ingot weight of steel
	GERMANY								
	COMBAT								
B-25	long range bombers	5095	11.845	.705	12.550	21.676	1.008	22.684	115575
A-21	Dive bombers and ground attack	1200	6.000	.200	6.200	10.980	.286	11.266	13519
P-40F	Single engine fighters	8585	5.000	.340	5.340	9.150	.486	9.636	82725
P-38	Twin engine fighters	2517	7.800	.310	8.110	14.274	.443	14.717	37042
Composite	Misc.(incl. Army coop & coastal)	1268	-	-	8.000	-	-	14.480	18360
	TOTAL COMBAT AIRCRAFT	18665							267221
	TRANSPORTS & TRAINERS								
C-46	Transports: 3 engined	600	10.826	.724	11.550	19.812	1.035	20.847	12508
C-54-A	Transports: 4 engined	240	15.391	1.384	16.775	28.166	1.979	30.145	7235
AT-6	light transports & trainers	7200	2.217	.167	2.384	4.057	.239	4.296	30931
	TOTAL TRANSPORTS & TRAINERS	8040							50674
	TOTAL GAF PRODUCTION	26705							317895
	OTHER AXIS								
	Italy (1/7 of GAF production)	3815							45414
	Other countries (1/20 of GAF prod.)	1335							15895
	TOTAL OTHER AXIS	5150							61309
	TOTAL AXIS AIRCRAFT	31855							379204
	Add: Other Airforce Stores (@10%)								417184
	Add: For spares: about 50%								625686
	Convert to metric tons								689694

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AXIS STEEL REQUIREMENT FOR MOTOR VEHICLES, 1943

TYPE OF VEHICLE	Annual Axis Production	Net Steel Content Per Vehicle (tons)	Steel required for new production			Total steel for production and maintenance		
			Net	Rough Stock	Ingot	Net	Rough Stock	Ingot
Cars	35,000	.75	26,250	35,000	47,000	39,375	52,500	70,500
Trucks	100,000	1.50	150,000	200,000	266,000	225,000	300,000	400,000
Motorcycles	32,000	.13	4,160	5,000	6,600	6,240	7,500	9,900
Total			180,410	240,000	319,600	270,615	360,000	480,400
Agricultural tractors	44,200	.60	26,500	35,300	47,000	39,750	52,950	70,500
Military tractors	30,200	3.00	90,600	120,000	160,000	135,900	180,000	240,000
Total			117,000	155,300	207,000	175,650	232,950	310,500
GRAND TOTAL			297,410	395,300	526,600	446,265	592,950	790,900

Notes :

1. All production figures from MEW, except trucks, which are based on OSS estimates.
2. Unit weights from MEW, after checking with US ordnance experts
3. Maintenance and spare factor of 50 per cent, MEW gives 25 per cent. US calculation of 35 per cent has been found somewhat inadequate Age distribution of European vehicles justifies the higher figures.

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CONSUMPTION OF STEEL IN AXIS EUROPE, 1942 and 1943

(000's of metric tons)

BREAKDOWN	OSS Estimate for 1943 Intermediate	OSS Estimate for 1943 Gross		MEW Estimates for 1942 Gross		Probable bias in MEW Estimate Gross	
MILITARY							
Ammunition		4,900	7,000		7,000	--	
Miscellaneous field equipment		2,100	3,000		2,900	--	
Armored fighting vehicles: Tanks	490		900				
Others	195	685	350		1,300	--	
	685		1,250				
Motor vehicles: Cars, truck, motorcycles	360		480	950			
Tractors (mil. and agri.)	233	593	310	250	1,200	• 400	
		425	790		850	--	
Artillery and small arms		1,625	850		3,000	--	
Direct military construction		400	2,600		600	--	
Aircraft		610	690		1,200	--	
Naval construction		10,338	870		18,050	• 800	
TOTAL MILITARY			17,050				
INDUSTRIAL AND CIVILIAN							
Railroads: Track and structures	1,600		2,300	3,200		--	
Locomotives and cars	3,650	5,250	5,500	5,900	9,100	• 2,200	• 2,200
	5,250		7,800				
Nonmilitary construction: Plants	400		640				• 500
Other	100	500	160		1,500		--
		552	810		1,000		
Merchant shipping			790				
Industrial:				1,100		--	
Mining and quarrying	500		850	650		--	
Carbonization industries	350		500	500		--	
Electric power	375		500	1,750		--	
Machinery, equipment, and tools	1,800		1,750	500		--	
Industrial supplies	375		500	450		--	
Chemicals and synthetics	480		780	--		--	
Repair and maintenance	300		400	2,000	6,950	• 1,000	• 1,000
Containers	700	4,360	1,000		2,050		• --
Agricultural equipment 1/		1,000	1,430		1,650		--
Miscellaneous and consumers' goods		800	1,150		22,250		• 3,700
TOTAL INDUSTRIAL AND CIVILIAN		12,162	18,200				
					40,300		4,100 36,200
GRAND TOTAL		23,800	35,250				

1/ Explosive or explosives.

Plants

U.S. 1943 consumption of steel (intermediate) in plant construction has been estimated at about 2.2 million tons, but consumption will be at a declining rate during the year; the annual rate for the last quarter is estimated at 1.5 million tons. As the Axis plant construction program should have been finished some time ago, about one fourth of the American level of construction should easily suffice for the construction of new plants, or extensions to plants in Eastern Europe and for small expansions carried out elsewhere.

Other

The U.S. will expend an estimated 650,000 tons of steel (intermediate) on other non-military construction this year, but also at a declining rate. In the last quarter the annual rate will be only 450,000 tons. It is unreasonable to expect Axis consumption to be much more than 100,000 tons: very few housing projects are under way; wood is being used extensively; little or no repairs are being undertaken on bombed housing.

Conversion rate of intermediate = gross = 62.5% based on MEW steel study.

SHIPBUILDING AND MARINE ENGINEERING

	Merchant	Naval	Total
	000's of metric tons		
1. TOTAL GRT	600	616	1216
2. Weight of steel in finished ships			
Hull	270	352	622
Main machinery & boilers	60	41	101
Aux. machinery	18	13	31
TOTAL FINISHED WT.	348	406	754
3. Weight of steel, intermediate form			
Hull (add 20%)	324	422	746
Main machinery) (add 100%)	120	82	202
Aux. machinery)	36	26	62
	480	530	1010
Add: repair work (add 15%)	552	610	1162
4. Weight of steel in ingot form			
Add 43% to all parts	789	872	1661

NOTES ON GRT (See attached table, from which above is derived)

Merchant Ships

ONI believes the MEW figure too high; on the basis of latest information, 600,000 tons seems to be a fair figure for merchant shipping.

Cruisers and Destroyers

Aerial reconnaissance does not indicate any particular heavy naval shipbuilding activity. It is believed that such construction will be at a level considerably below last year's.

Escort Vessels

No reason to change this figure.

Minesweepers

Aerial reconnaissance suggests a considerable expansion in the construction of minesweepers.

Submarines

OSS estimates an output of submarines which is about 30% above the MEW estimate.

E/R Boats

No reason to change this figure.

Tank Landing Craft, Siebel Ferries, Barges

Aerial reconnaissance indicates a marked decline in the output of TLC. It is difficult to believe that the Axis would produce as many of this type craft in 1943 as they did in 1942.

Pontoons and Small Craft

No reason to change this figure.

Floating Docks, etc.

Construction of this type will probably be lower in 1943.

INDUSTRIAL EQUIPMENT

Mining and Quarrying

The MEW figures of:

	Net	Intermediate	Gross
Coal	450,000	500,000	700,000
Other	200,000	250,000	400,000
TOTAL	650,000	750,000	1,100,000

seem to be fairly reasonable, although the 1943 figure may be below that of 1942 to a small degree, due to bombings in the Ruhr area. A figure of 850,000 tons (gross) is thus probably nearer the truth. Intermediate requirement is thus 580,000 tons.

Carbonisation Industries

The same is probably true of the carbonisation industries, which the British estimate for 1942 as:

Net	350,000
Intermediate	400,000
Gross	650,000

A figure of 500,000 gross and 350,000 tons intermediate seems reasonable for 1943.

Electric Supply

The MEW estimate of 375,000 tons (intermediate) and 500,000 tons (gross) for 1942 appears to be a good figure for 1943 as well; the capacity expansion figures have been checked by MEW experts on electric power.

Industrial Machinery, and Equipment, and Tools

This item must be estimated only roughly at best. The MEW placed it at 1,200,000 tons intermediate and 1,750,000 tons gross for 1942. Consumption in the U.S. for this purpose in 1943 will be in the area of 3.0 - 3.5 million tons intermediate. It seems reasonable to believe that a ratio of 2.5:1 or 3.0:1 between this country and Axis Europe for this type of equipment construction is a fair one. The MEW figure is, therefore, retained uncharged.

Industrial Supplies

MEW gives no explicit figure for this item, except for 500,000 tons (gross) for binding and fastening materials. This figure will probably suffice for all industrial supplies; the U.S. 1943 requirement for this item is about 1,300,000 tons gross. The intermediate figure is 375,000 tons.

Chemicals and Synthetics

According to MEW a 35,000 tons p.a. Fischer-Tropsch plant consumes 6,000 tons of steel (intermediate); larger plants use less steel in proportion to output. Requirements for hydrogenation plants are probably a little higher per unit of output. It is estimated that Fischer-Tropsch capacity will expand by 240,000 tons a year in 1943 and hydro by 650,000. On this basis, intermediate requirements of steel are estimated at 40,000 tons for Fischer-Tropsch and 120,000 for hydro.

Using the same formula as in the MEW study, the requirement for the rest of the chemical industry is estimated at 320,000 tons intermediate.

The total requirement is thus 480,000 tons intermediate and 720,000 tons gross.

Repair and Maintenance of Plant and Equipment

MEW has no separate allocation of steel for this purpose; presumably it is subsumed under Industrial Machinery, Equipment, and Tools. Some separate mention should probably be made, however, in view of the deterioration

of plant and equipment in Axis Europe, as well as the bombing raids over congested industrial areas. The U.S. figure for 1943 is about 600,000 tons intermediate and 825,000 tons gross. It is obvious that the Axis figure will be nowhere near this figure, but it seems reasonable to assume that as much as 40-50% of the amount will be used. The estimate is, therefore:

Intermediate	300,000
Gross	400,000

Containers

U.S. 1943 consumption of steel (intermediate) for containers is estimated at about 1.5 million tons. The MEW estimate, on this basis, appears to be disproportionately high, probably because it was arrived at by taking a flat percentage of total steel consumption. The U.S. figure is equal to about 5% of civilian steel consumption for 1943 (excluding shipbuilding and exports). A figure of 700,000 tons (intermediate) for the Axis seems fair enough. The comparable ingot figure is 1,000,000 tons. This is equal to about 6% of Axis civilian consumption, excluding shipbuilding.

AGRICULTURAL EQUIPMENT (Excluding Tractors)

The MEW estimate for steel required agricultural equipment in 1942 is 1.4 million tons intermediate and 2.0 million tons gross. This is probably a fairly good figure. U.S. consumption of steel in agricultural equip-

ment is estimated at 1.0 million tons intermediate, but production of such equipment has been severely restricted, while it has a relatively high priority in Axis Europe. The British estimate is probably on the high side, particularly since output in 1943 is believed to be lower than in 1942. For 1943, Axis Europe's consumption is therefore probably on the order of the U.S. figures.

MISCELLANEOUS AND CONSUMERS' GOODS

Exports

The MEW figures of 150,000 tons intermediate and 250,000 tons gross are accepted as reasonable.

Consumers' Goods

Output of consumers' goods containing steel is probably very small in Axis Europe at the present time. In the U.S., about 300,000 tons of steel (intermediate) will be consumed for this purpose. Probably about one-half this amount will be used in Axis Europe. The gross figure is about 200,000 tons.

Miscellaneous

This catch-all is given by MEW for 1942 as 1 million tons intermediate and 1.4 million tons gross. British experience shows that repair requirements of iron and steel for public services under air bombardment are not a very significant factor. The U.S. requirement for gas, water, and sewage for civilian purposes is

about 300,000 tons in the intermediate stage. Considering this factor and the general coverages of the study, the British figure appears rather excessive. No more than 500,000 tons intermediate should be required for miscellaneous purpose (700,000 tons gross).

Total	Intermediate	Gross
Exports	150,000	250,000
Consumers'	150,000	200,000
Miscellaneous	500,000	700,000
TOTAL	800,000	1,150,000

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TABLE III

City AA Defenses

City	Date	Heavy Guns	Light Guns	Searchlights
Germany				
Northwestern				
Hanover	Sept., 1942	100	100	75
Bremen	" "	180	300	60
Wilhelmshaven	" "	70	125	35
Osnabruck	" "	20	45	12
Hamburg	" "	200	240	100
Kiel	" "	100	125	75
Emden	" "	50	75	30
Lubeck	" "	62	90	35
Western				
Essen	" "	100	60	35
Dortmund	" "	28	75	50
Munster	" "	40	60	30
Cologne	" "	240	255	120
Dusseldorf	" "	50	75	50
Duisberg	" "	40	30	25
Kassel	" "	28	60	15
Southwestern				
Frankfort A/M	" "	70	110	35
Karlsruhe	" "	24	60	20
Mannheim	" "	80	125	50
Friedrichshaven	July, 1943	56	75	10
Saarbrucken	Sept., 1942	16	15	5
Central				
Berlin	" "	240	300	125
Rostock	" "	34	75	35
Stettin	" "	34	60	20
Goering Works near				
Braunschweig	" "	48	60	2
Nürnberg	" "	70	50	50
Augsburg	July 1943	84	75	50
Eastern				
Gdynia	Sept., 1942	24	36	9
28 cities in Germany		2,088	2,756	1,158

Source: AA Command Intelligence Summary Sept. 19, 1942 and M.I. 14 AA Summary 291, July 1943.